



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# DOE SSL Research & Development Program Update

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Office of Energy Efficiency and Renewable Energy  
Buildings Technologies Program

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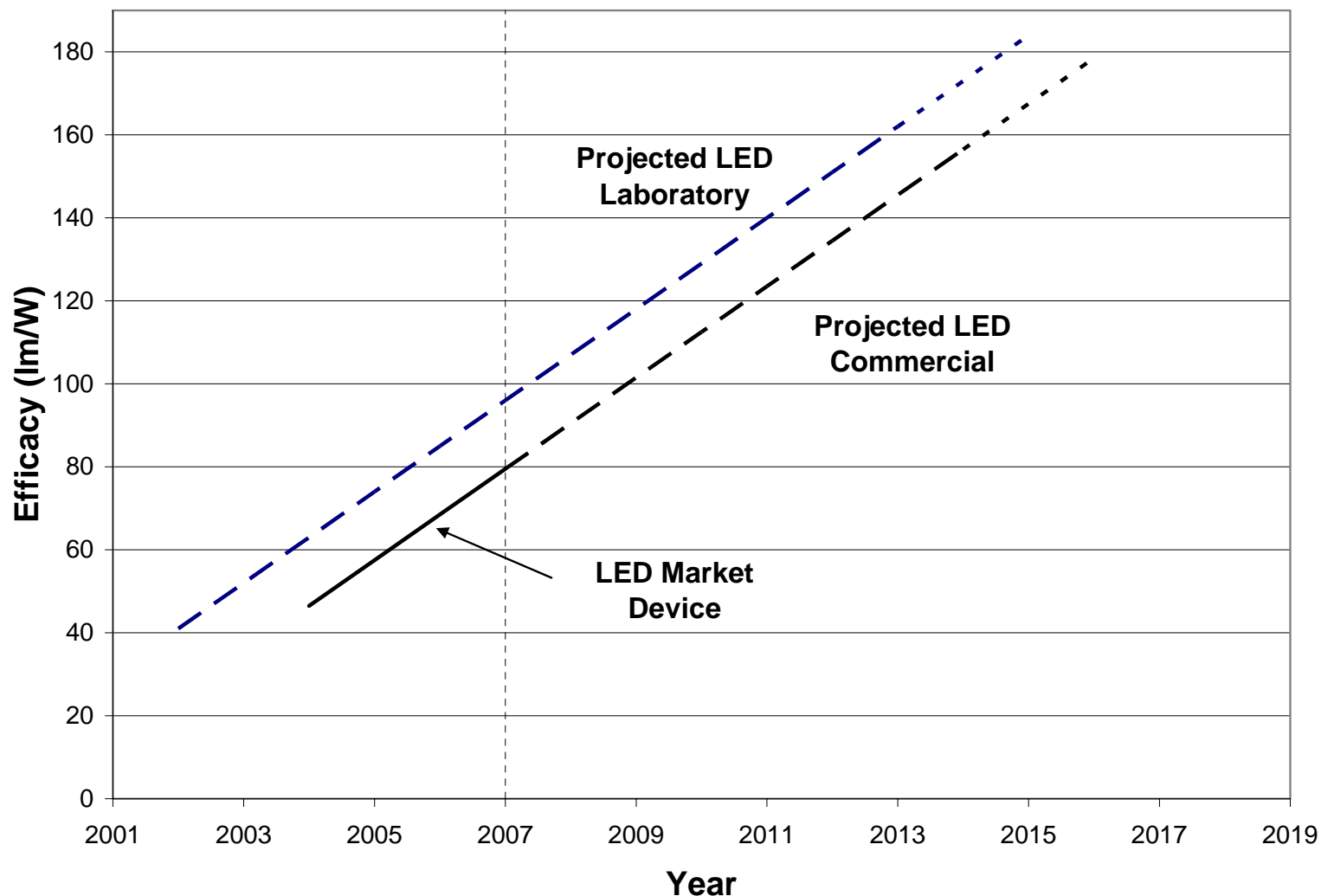
# Mission Statement

## **Solid-State Lighting Program Mission**

**Guided by a government-industry partnership, the mission is to create a new market for high-efficiency, general illumination products through the advancement of semiconductor technologies, to save energy and enhance the quality of the lighted environment.**

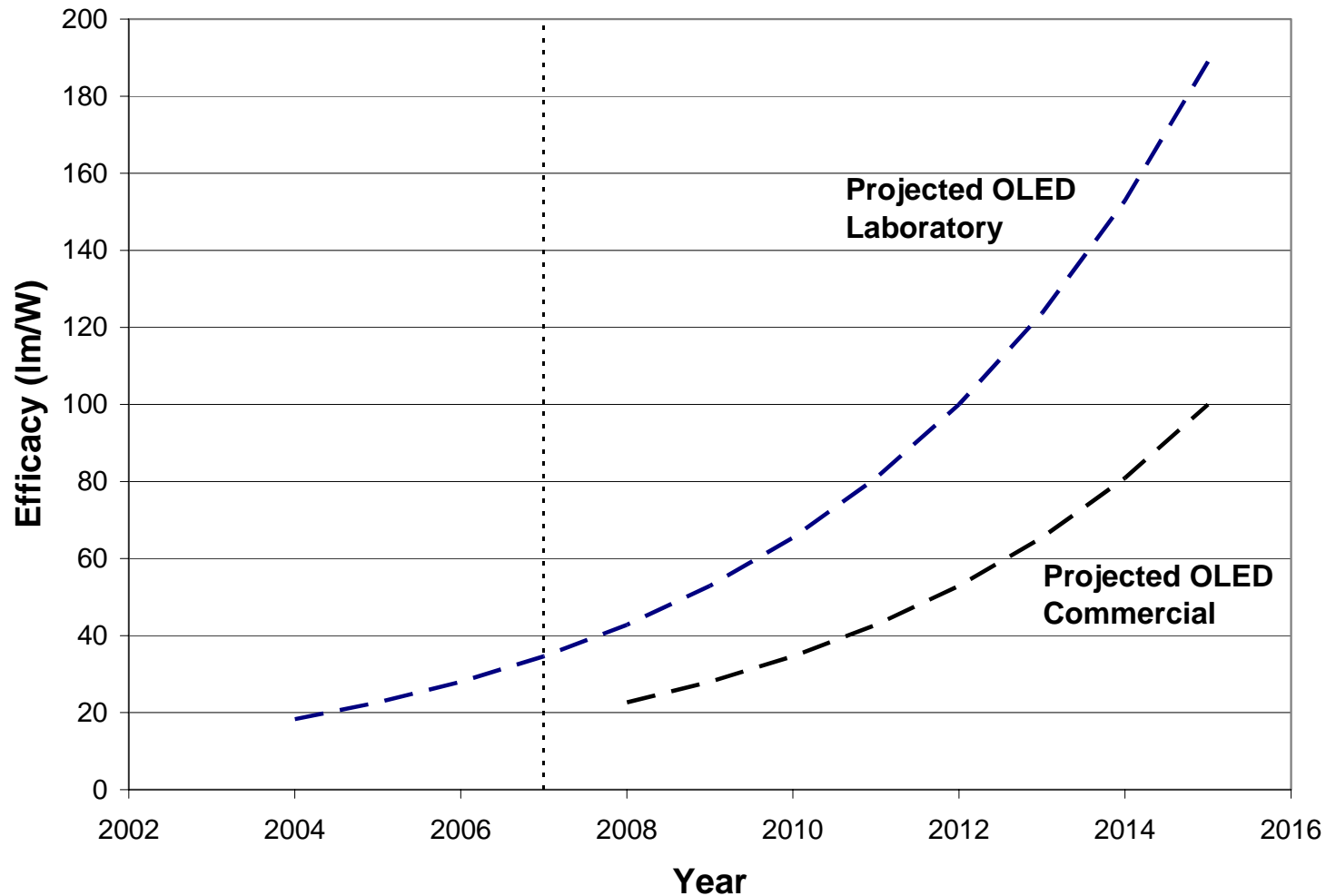


# White-Light LED Efficacy Targets





# White-Light OLED Efficacy Targets





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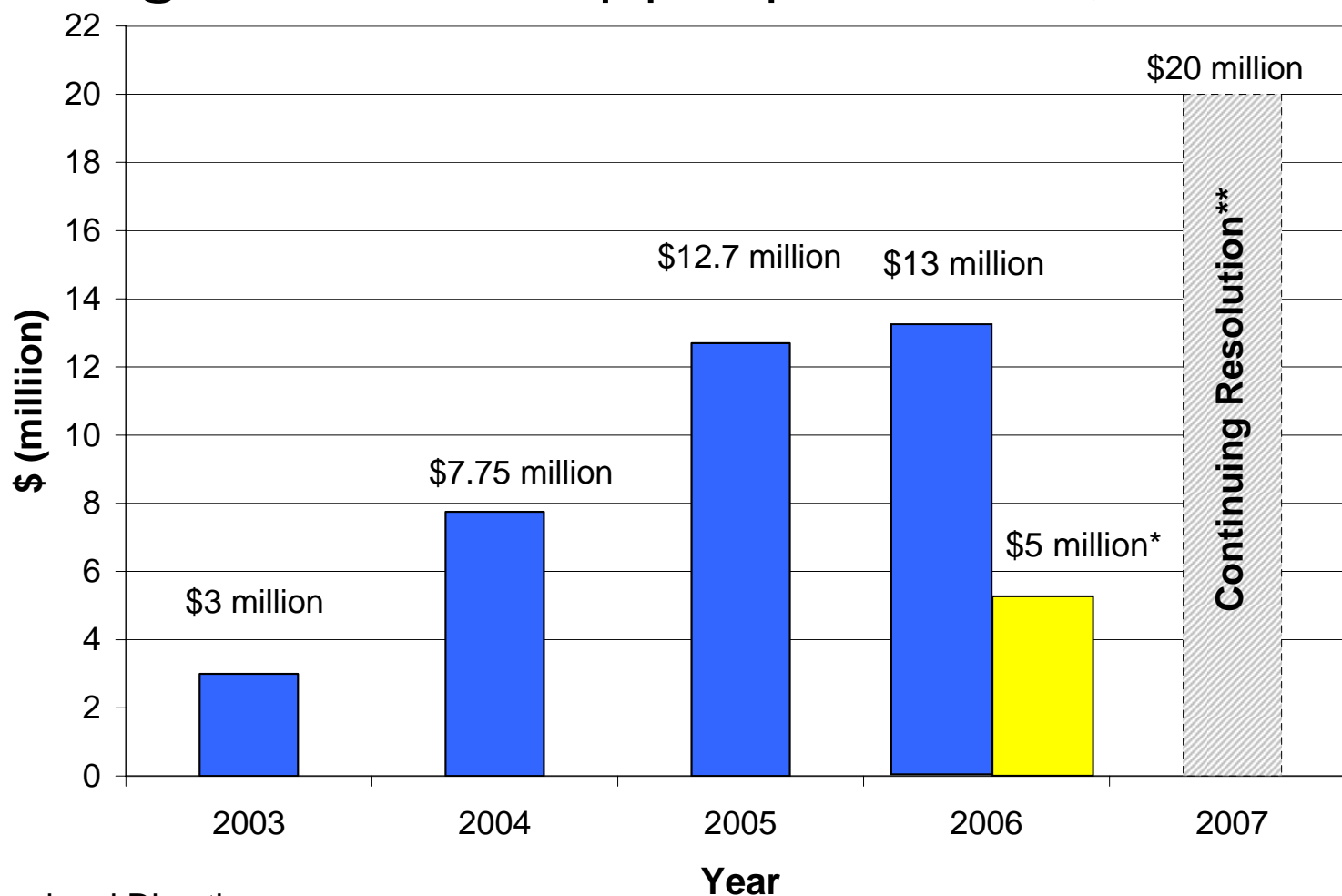
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# Congressional Appropriation (\$ million)

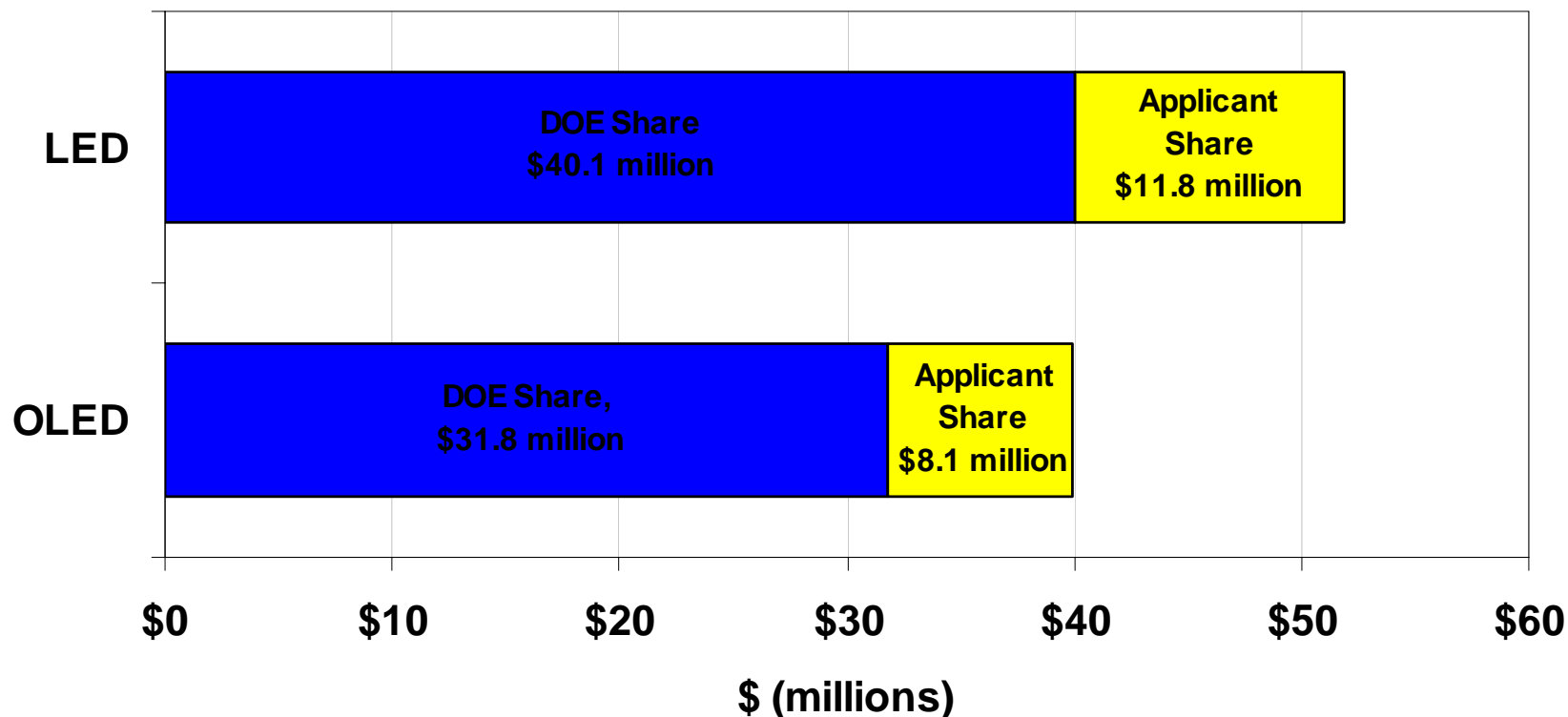


\*Congressional Directive

\*\*Congressional Budget is not yet approved



## SSL R&D Project Funding



Total Contract Value of Projects: \$91.8 million\* (64 projects)

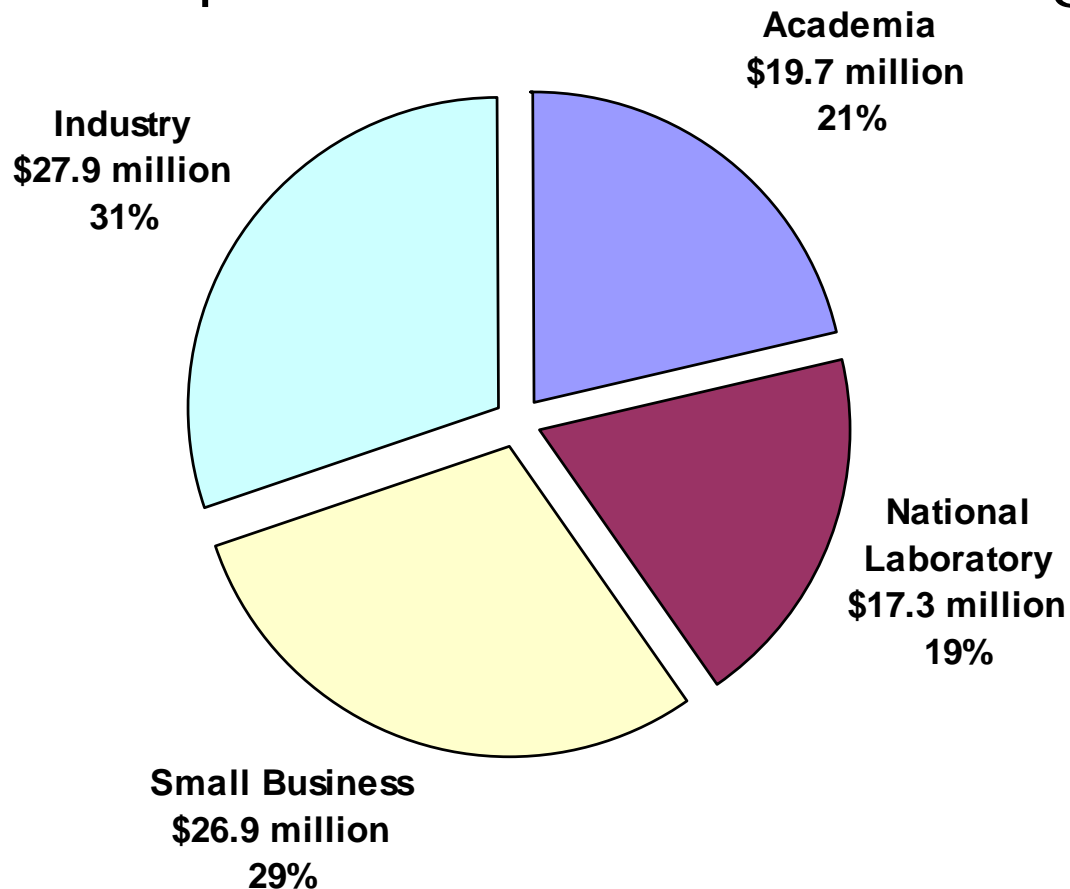
- OLED: \$39.9 million (28 projects)
- LED: \$51.8 million (36 projects)

\* The total contract value includes DOE funding (\$71.9 million) and applicant cost-share (\$19.9 million)





## Recipients of DOE Funding



- The Department funds solid-state lighting research in partnership with industry, universities, and national labs.



# Total Portfolio: LED Core Technology

	# of Projects	Funding (\$ million)
<b>Light Emitting Diode Core Technology</b>		
Large-area substrates, buffer layers, and wafer research	2	\$1.4
High-efficiency semiconductor materials	15	\$22.0
Device approaches, structures, and systems	2	\$3.7
Strategies for improved light extraction and manipulation	1	\$0.8
High-efficiency Phosphors and conversion materials	5	\$7.4
Encapsulants and packaging materials	1	\$0.1
Design and development of in-situ diagnostic tools for the substrate and epitaxial process	2	\$1.0
Research into low-cost, high efficiency reactor designs and manufacturing methods	1	\$0.8
<b>Total</b>	<b>29</b>	<b>\$37.1 million</b>



# Total Portfolio: OLED Core Technology

	# of Projects	Funding (\$ million)
<b>Organic Light Emitting Diode Core Technology</b>		
Substrate materials for electro-active organic devices	2	\$0.9
High-efficiency, low voltage, stable OLED materials	12	\$13.2
Improved contact materials and surface modification techniques to improve charge injection	1	\$0.7
Strategies for improved light extraction and manipulation	2	\$1.8
Approaches to OLED structures between the electrodes for improved-performance low-cost white-light devices	1	\$0.8
Research on low-cost transparent electrodes	4	\$4.4
Investigation (theoretical and experimental) of low-cost fabrication and patterning techniques and tools	1	\$4.0
<b>Total</b>	<b>23</b>	<b>\$25.8 million</b>

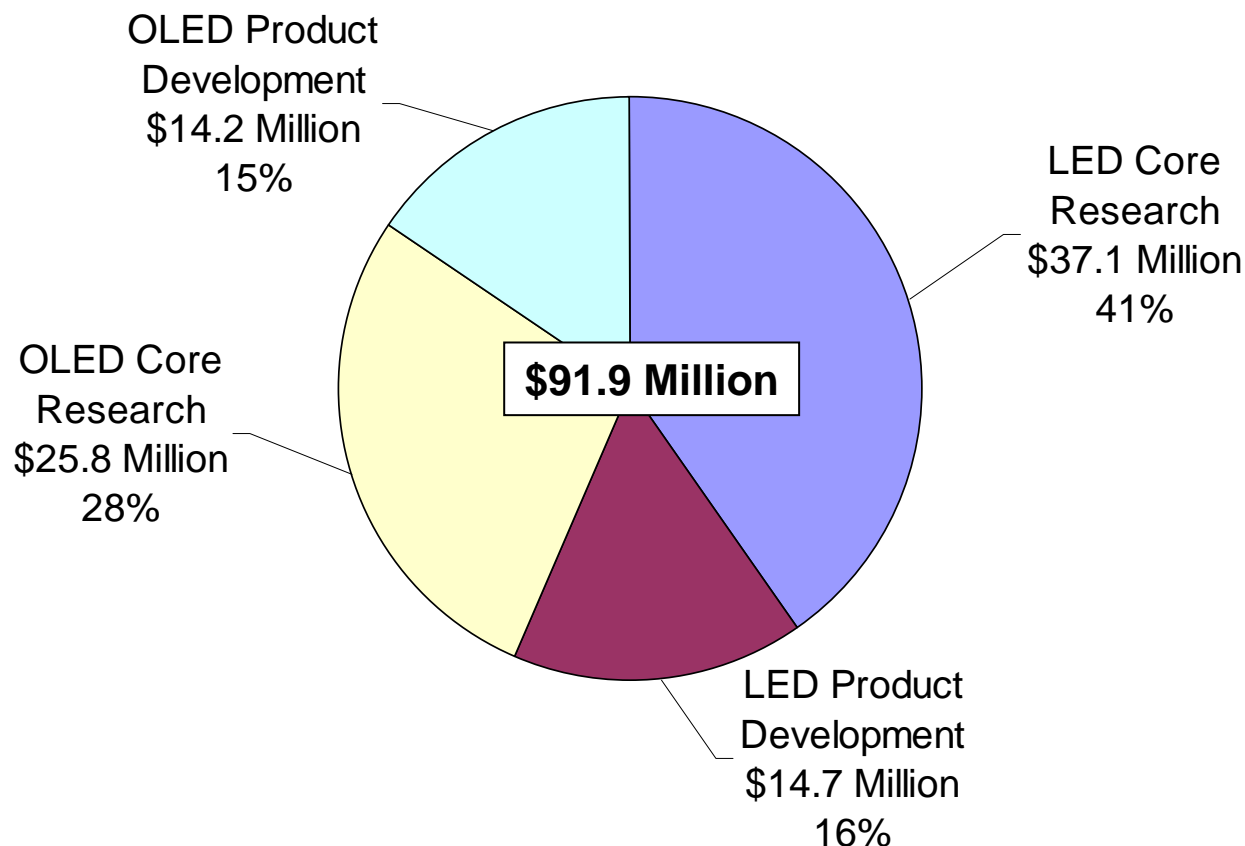


# Total Portfolio: Product Development

	# of Projects	Funding (\$ million)
<b>Light Emitting Diode</b>		
High-efficiency semiconductor materials	1	\$1.9
Implementing strategies for improved light extraction and manipulation	2	\$3.7
Optical coupling and modeling	3	\$6.5
Electronics development	1	\$2.6
<b>Organic Light Emitting Diode</b>		
Develop architectures that improve device robustness, increase lifetime and increase efficiency	5	\$14.2
<b>Total</b>	<b>12</b>	<b>\$28.9 million</b>



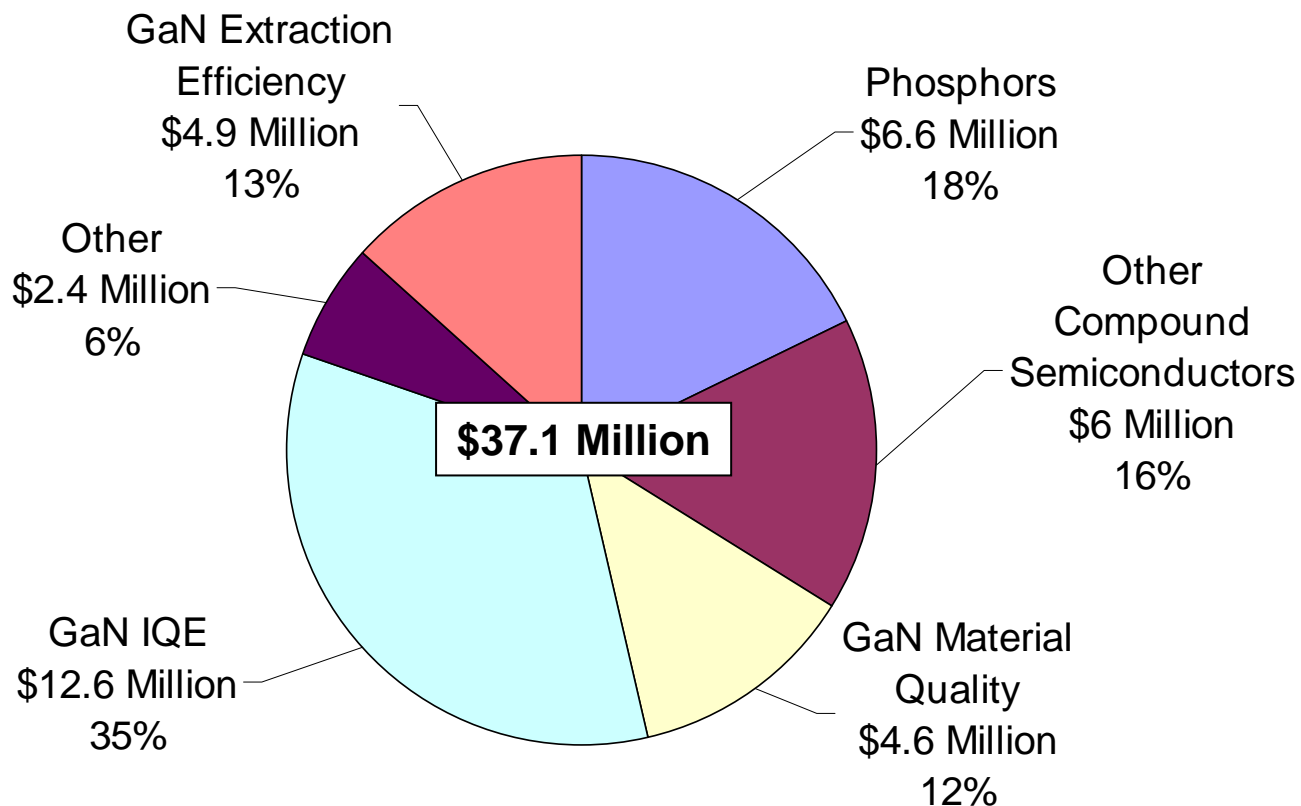
# LED and OLED Product and Core Research



- Of the 64 total projects, 29 are LED core research projects, 7 are LED product development projects, 23 are OLED core research projects, and 5 are OLED product development projects.



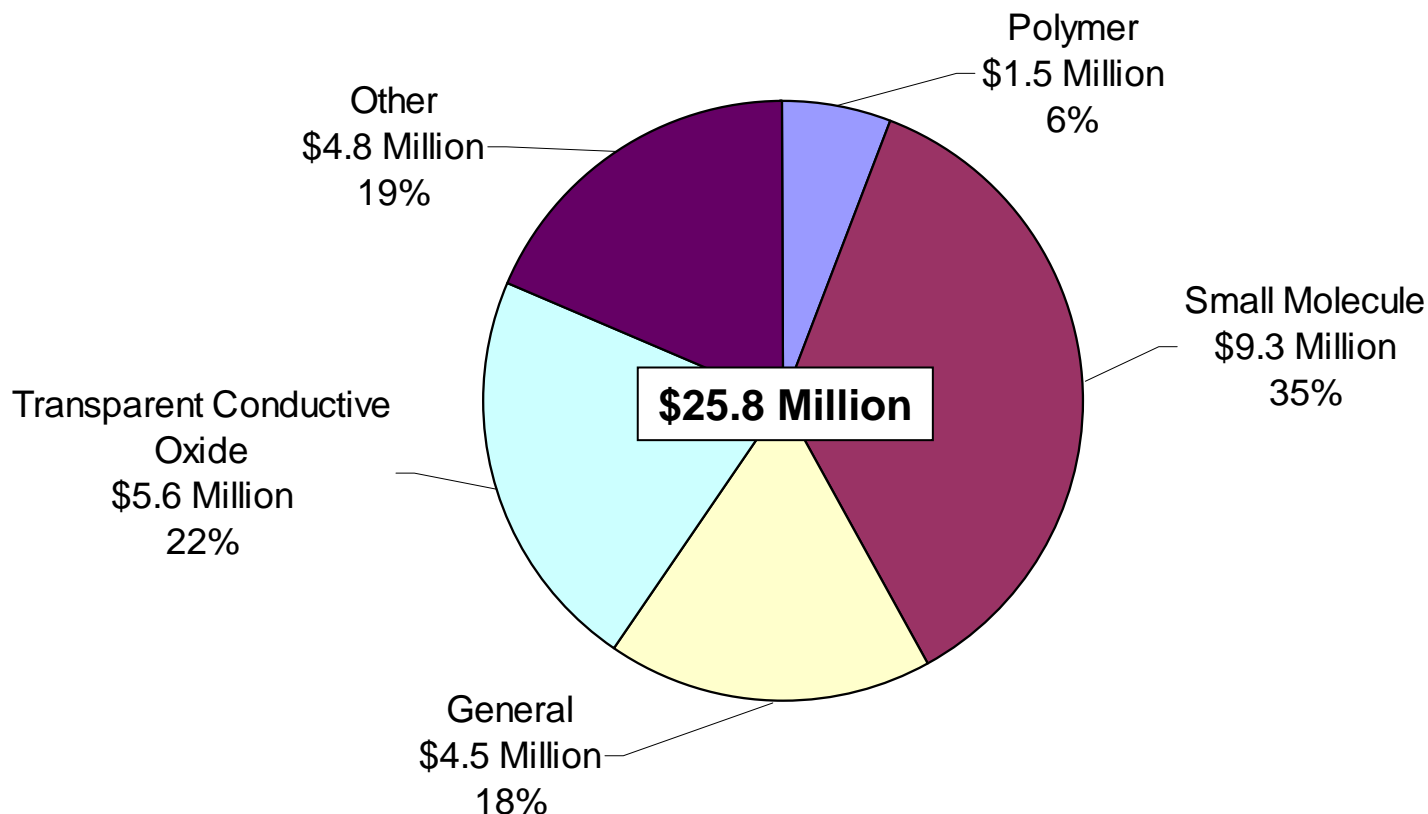
# LED Core Research



- Of the 29 LED core research projects, 3 are researching phosphors, 2 are studying other compound semiconductors, 19 are researching GaN LEDs, and 5 projects are studying other areas.



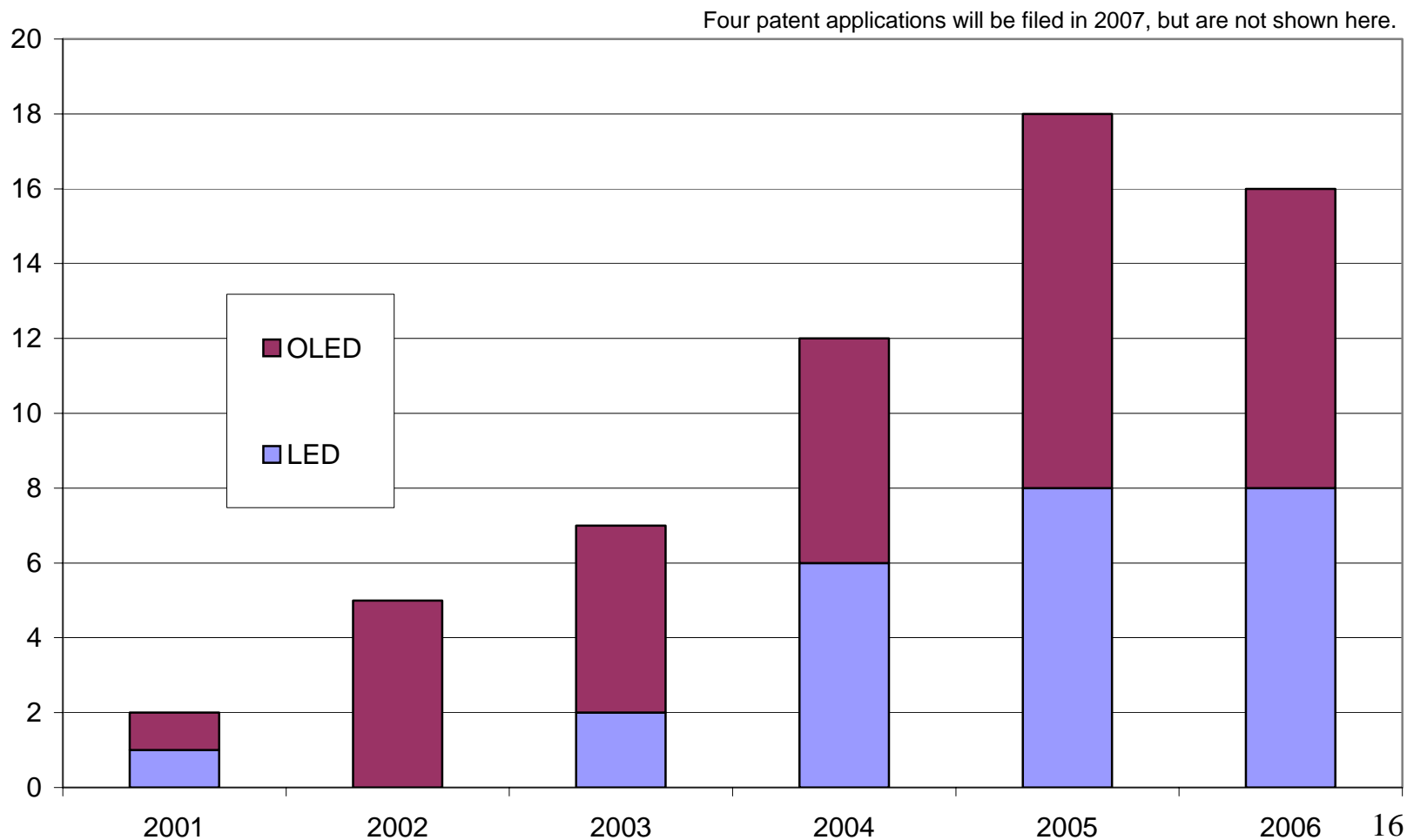
# OLED Core Research



- Of the 23 OLED core research projects, 4 are studying general OLEDs, 1 is researching polymer OLEDs, 4 are studying small molecule OLEDs, 5 are researching transparent conductive oxides, and 9 are researching other areas.



## Solid State Lighting Research and Development Intellectual Property, Patents by Year







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## PNNL Blue OLED Device Exceeds DOE FY07 Joule Target

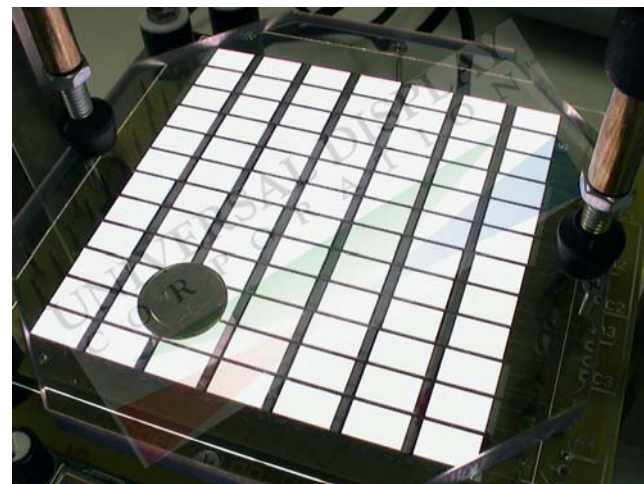
- Blue OLED with EQE of 11% at 800 cd/m<sup>2</sup>
- New molecular structure enables use of blue organic phosphors at low operating voltage
- Potential for much higher power efficiencies





## USC Team Explores Novel Approach to Increase OLED Performance

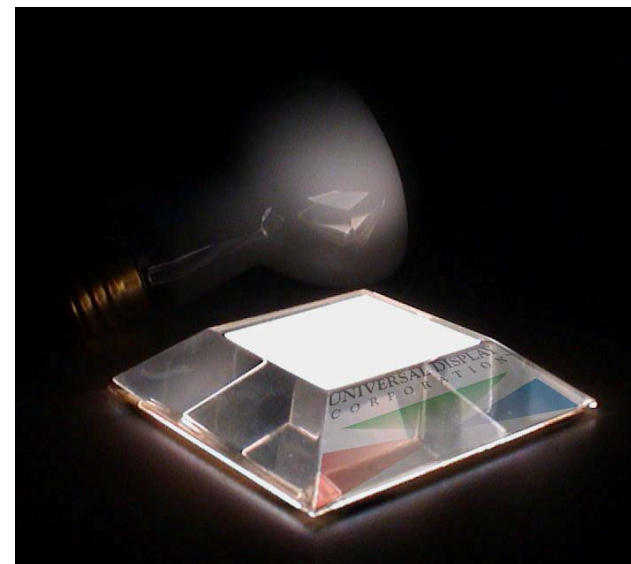
- Combination of blue fluorescent and red and green phosphorescent dopants
- Device efficiency: 24 lm/W
- Improved lifetime and color stability versus standard OLEDs





# UDC Achieves Record Quantum Efficiency in White OLED

- EQE: 30%
- Efficacy of 30 lm/W with CRI of 70
- Improved light extraction with novel microlens arrays and aperiodic gratings





## TDI Improves Semiconductor Components for LED White Lighting

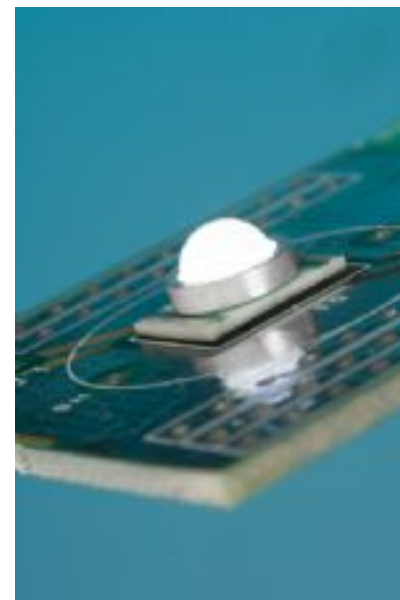
- Novel, low-defect GaN template substrates and InN epitaxial wafers
- Materials used for fundamental research, product development, and production of high efficiency, high-brightness LEDs





## Cree XLamp® and EZBright™ Chip Deliver Record Performance

- New LED XLamp: 85 lm/W
  - Improvements in optical design and architecture
  - Uses new EZBright power chip
  - Brightness allows general illumination applications
- EZBright chip: 370 mW at 350 mA
  - Twice as bright as current Cree chips





***“Even if you’re on the right track  
you’ll get run over  
if you just sit there.”***

**Will Rogers**

